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An Investigation of Surface Patterns, Spatiality and Pattern Relations in Textile Design

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Abstract
This research focuses on surface patterns, spatiality, and pattern relations in textile design, and aims to explore surface patterns as spatial definers and what they mean in the context of surface patterns. Primary focus of the research relates to applying conceptual spatial determinations as alternative variables in pattern design processes, and exploring how these were used to define and analyse pattern relations. Series of exploratory design experiments were conducted using printed and projected surface patterns in a two and three-dimensional setting which was documented using photographs and films with pattern relations, wherein scale used as a design variable. The outcome of the experiments showed the expressional possibilities that surface patterns may provide in a defined space and how these are connected to pattern relations. In order to encourage an accompanying discussion regarding alternative methods of analysing surface patterns, the construction of a theoretical model was initiated. Workshops with design students were used as another practical method in this work. The results showed that there is great potential in using conceptual spatial determinations to define pattern relations by viewing surface patterns as spatial definers, rather than taking a traditional perspective on their functions. Another outcome is the theoretical model, which proposes a specific approach to pattern relations. This research demonstrates how conceptual spatial determinations can benefit the textile design process, as well as design teaching, which could in turn provide the field with new expressions that may lead to a change in or fruitful addition to the practice. This research demonstrates how conceptual spatial determinations can benefit thetextile design process, as well as design teaching, which could in turn provide thefield with new expressions that may lead to a change in or fruitful addition to thepractice.

Keywords: *Surface patterns, textile design, spatiality, spatial definers, designvariables, pattern relations, conceptual spatial determinations*

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I. Introduction

The term ‘pattern’ has been widely discussed from many perspectives, and itsmeaning varies on the based on the context in which it is used. For example,‘pattern cutting’, ‘patterns of movement’, and ‘patterns of behaviour. Accordingto the Merriam-Webster Dictionary (2016), a ‘pattern’ is “repeated form or designespecially that is used to decorate something. The regular and repeated way inwhich something happens or is done or something that happens in a regular and repeated way”.In the fields of interior architecture, design, fashion, and textiles, the term ‘pattern’ is defined quite specifically.Patterns is the natural outgrowth ofrepetition, where the repeat system discloses the construction (Day,1999). He states that,“technically speaking it can be understood that patterns arethe recurrenceof similar forms, but of their reappearance at regular intervals”.Patterns are often viewed in terms of visual pleasure, used to organise surfaces, andstrongly associated with textiles.

Fenn(1993) has a similar conception of patterns, claiming that their essence is repetition,ensured by the production processes of wallpaper and printed and woven textiledesign, for example. Seen in this light, a pattern consists of a mechanically repeatedunit that covers a small part of the printed or woven area.Kraft (2004) discusses textile patterns and their production processes with regard to textiletechniques, presenting a formulated definition of the term ‘pattern’ and introducingthe ideas of rhythm, symmetry, repetition, and dimension in relation to the term inorder to establish a scientific approach to the concept. According to Bell (1999), a landscape architect, argues in *Landscape: Pattern, Perception, and Process*that the most general definition of a pattern is “the opposite of chaos”.Pattern recognition is important in helping us to understand and relate to the worldaround us. Within architecture, pattern is a set of spatialelements: points, lines, planes, or volumes, in two or three dimensions.

In addition to visual patterns, which can be considered to be concrete in the sensethat they are easily observed using our sight, there are also abstract patterns, as canbe found in the fields of mathematics and psychology.The mathematician and writer Devlin (1996) considered mathematics to be the scienceof patterns, which can be found everywhere in the physical universe, including inthe living world and our own minds. Similarly, Feynman (2005) offers a concisedefinition, claiming that “mathematics is looking for patterns”.The term ‘spatial pattern’ is used in a relatively restricted sense within the fieldof psychology. The Online Psychology Dictionary (2017) defines a pattern as a“temporal or spatial arrangement of independent components to make an involvedwhole”. Here, then, patterns are limited to the domains of time and space.

Development of Repeat Patterns in Relation to Printing Methods

Like most industries, the textile industry has changed a great deal in recent decades,and this has had a large impact on surface pattern design (Gale and Kaur, 2002). Oneimportant issue that is related to textile design is its connection to surface patterns.Repetition is essential for creating a pattern and the core of all pattern designs,and the correlation between pattern unit and repetition is crucial in allowing peopleto recognise a textile in terms of its construction and production. This interplayis fundamental for textile design practice, as well as for an understanding ofmanufacturing and production methods.During the period of industrial revolution, production was the absolute measure; machinesset the conditions and provided the instructions for repeating a patterns in designs.

William Morris began to design textiles in the 1860s, claiming that mechanisationhad resulted in a lowering of design standards and manufacturers focusing onquantity rather than quality. Morris researched medieval manufacturing methodsthat used traditional craft skills, techniques, and processes, and was opposed tomost contemporary forms of production for both aesthetic and political reasons(Mabb, 2009). This was visible in his designs which, in advocating transparency,always revealed the structural, material, and functional properties of objects. Morrisreintroduced an experimental, artistic method of block printing, which demonstratedthe basic idea of interweaving foreground and background motifs into a more orless two-dimensional picture (Tilburg, 2012). Morris’s way of experimenting withmethods and production provided a recognisable aesthetic expression, and exploitedthe available techniques to enable pattern repetition.Examining printing techniques throughout history, shows that certain mechanicalprerequisites govern pattern repetition.

Resist-printing patterns are applied usinga paint brush or a special, pen-like tool called a ‘tjanting’. In tie dying, small objectsare knotted or stitches are sewn into the cloth to create a repeating pattern. Mordantprinting is similar to resist printing; a pattern is applied using painting, printing, ora block (Russell, 2011). These printing techniques involve a great deal of work byhand, and repetition is not restricted by any mechanical process; rather, the makerdecides how it is to be achieved.In block printing, the pattern motif is carved into pieces of wood, and dyestuff isapplied; through pressure, the motif is transferred onto the fabric. Pattern repetitionis restricted by the size if the blocks which must, for example, not be too heavy to belifted by one person.

In copper-plate printing, a design is cut into the surface of a copper plate andtransferred to the fabric with a press (in the manner of graphical printing). With thistechnique, pattern repetition is limited by the size of the plates and, as most copperplates are very large and heavy, ‘island designs’, wherein elements of the design areplaced independent of other elements, are common (Briggs-Goode, 2013).Copper roller printing and rotary screen printing each involve a similar approach.The designs are cut into or engraved on the surface of copper or nickel tubes;pattern repetition is constrained by the size of the roll, and each repeat is generally64 or 91.3 cm long.In flat screen printing the pattern is transferred onto the fabric using a coated mesh,with a squeegee often being utilised to push the dyestuff through the stenciled pattern onto the fabric. The sizes of the screens vary, but are usually 1.5 m wideand between 1 and 3 m long (Russell, 2011). Repetition is not necessarily technicallyrestricted in terms of height, but width.

In heat-transfer printing, a design is printed onto paper with disperse dyestuff usingheat to transfer the design onto the fabric, which needs to be made of a syntheticmaterial (Briggs-Goode, 2013). Pattern repetition is not limited; rather, the size ofthe heat-transfer machine and the paper regulate the print size and pattern repeat.An engineered or placed pattern is ideal for use with this technique.In digital printing, the motif is created digitally and printed directly onto the fabricby inkjet printing (Clarke & Harris, 2012). The repetition of the pattern has neitherhorizontal nor vertical limitations, nor is it constrained as regards the amount ofcolours that it may contain. Moreover, there is no need to repeat the pattern laterally.Laser cutting is not, in technical terms, a printing technique, but may be used to cuta design out of a piece of fabric or remove a thin layer of fabric from the surface,etching a pattern into it (Russell, 2011). Pattern repetition has no limits; rather, it isthe size of the fabric that governs the pattern/motif. With digital tools and software,the same is true; computational design could be used to apply or project patternsonto any surface. Pattern repetition is unlimited, and dynamic and movable featuresare possible.

In mechanically produced fabrics, the repetition of a pattern unit is a technicalrequirement. The continuing development of machinery and computerized manufacturing methods challenges the ways in which textile designers design,and demands new ways of thinking (Briggs-Goode & Townsend, 2011). Technicaldevelopment within printing techniques has broadened perspectives on the conceptof pattern repetition, affecting the scale of surface patterns. Designers are today lesscontrolled by production methods and able to actively ignoring the restrictions thatwere once imposed, opening up for the possibility of experimenting with aestheticsand means of expression. Links between science, design, and new technologies arealso having an enormous effect, challenging the ways in which people think anddesign.

Repetition, Joints, Order and Scale

There are several components that are vital to understanding patterns. In this research, the definition of the term Pattern relates to the following concepts, and has its foundation in the above-mentioned sources. Repetitionis essential for creatinga pattern, and is the core of all pattern designs, while joints bind a pattern's unitstogether such that a pattern is created. Seen from a psychological perspective, Orderis our search for meaning, and our efforts to find order determine the appearanceof patterns. A systematic and logical structure facilitates understanding of a pattern (Gombrich, 1984). Scaleis a relative level or degree, and communicates relationshipsbetween elements. A change in scale means new challenges and new designdecisions.

Spatial Definers and Conceptual Spatial Determinations

In this research, surface patterns are regarded (or interpreted) as spatial definers; a pattern will be looked upon as something that decides (or states/establishes/governs/ determines) a room or spatial area. Surface patterns thus contribute to defining rooms/spaces. Conceptual spatial determinations are tools in the design process that can be used to explore how a surface pattern can clarify a spatial relationship.

Pattern relations. Theseareconcepts that are used in various settings contexts, and have severalmeanings. It could be found for instance in mathematics and geometry, computer engineering, and in bio-medicinal matters (Toussaint & Toussaint, 2014); in each,it has its own meaning. In this research, the term of 'pattern relations' refers to therelationship between a surface pattern and a spatial area.

Design Variables. When designing patterns, *design variables*are used in order to achieve a certainexpression. These are the designer's 'tools', the information that is needed to expressintentions within a textile. (Worbin, 2010). A textile designer is presented with a nearendlessnumber of design variables to work with in the design process; colour, form,line, texture, volume, etc. Designing surface patterns in spatial contexts demandsknowledge regarding which space to work in, kind of material to use, and type ofexpression is to be achieved. A design variable is simply something that thedesigner decides upon during the process of designing.

Surface Design and Surface Patterns. Today, surface design means different things to different people, and can refer to applications as diverse as textiles, architecture, and software. The definition of the term varies: in an interior textile context, it relates to the appearance of the fabric surface in terms of colour, texture, and, if applicable, pattern (Rowe, 2009); to TheSurface Design Association (SDA):

The notion of surface patterns came to be prominent among many interests. During art education, focus is made on expression, proportions, form, andline, thinking primarily of unique objects and freestanding works of art. Several crucial realisations regarding surface patterns, each of which hada great influence on the future textile design described as follows.

- **Repetition**: This is the core of all surface patterns.
- **Joints**: Theses are central to units in repetition.
- **Sense of order**: Is a systematic and logical structure or a distinct order.
- **Scale:** Is a critical component in understanding surface patterns which relates to attraction of visual surfaces wherein the border between motif and surface pattern is fluid.

Theoretical Model

The theoretical model created for the work described in this research is based on the conceptual spatial determinations introduced as an analysis tool. The model was somewhatinspired by the structure of Creating a Research Space (CARS), a model that wasdeveloped by Swales (1990) and based on his analysis of journal articles representinga variety of discipline-based writing practices. The CARS model is used to create aresearch space and context in which writing may take place. Two types of challenge(competition) are introduced; Creating a rhetorical space, andAttractingreaders into that space (Swales, 1990).Like Swales' model, the name of this model derives from its subject matter:Analysing, Conceptual
Spatial, Determinations= ACSD model**.**

The model proposes three actions or "moves" (in the diction of Swales), accompaniedby specific questions that relate to what is being analysed.

Move 1 Establishing Relationships

Start by discerning what relationships should be defined. What types of relationshipsare to be scrutinized? Which features are to be analysed? Is it, for instance, therelationship between the object and the background, surface pattern and spatiality,or scale and material? With a starting point in the exercises described above, therelationships simply presented themselves. Considering surface patterns from ageneral viewpoint, the relationships described above could be adapted relativelyeasily, although more specific relationships, such as that between a repeatingmethod and a motif or between colours, could also be explored.

Move 2 Classifying Concepts

Continue by stating the categories of concepts. What kind of concepts are to beapplied: word classifications, conceptual elements, visual components, or others?Again – based on the outcomes of Exercises 1-3 – the various setups provided theconditions for choosing one or another, and facilitated exploration of the motif andits expression in each example. The categories of concepts were notions deemed bythe author to be of value in analysing surface patterns.

Move 3 Defining Determinations

In this context, the conceptual spatial determinationswere employ to describe relationships. Whatkind of concept/expression is adequate? This follows on from Move 2, and dependson which concept is chosen. If word classification is picked, adverbial conceptsshould be employed; if conceptual elements and/or visual components are selected,tangible conceptions that describe form and space should be applied. As in Moves 1and 2, having an idea of what to analyse simplifies the choices to be made.Design theorists, designers, and scientists have developed various models foranalysing surface patterns and conducting pattern recognition. Hann carried outan extensive survey of the fundamentals of pattern structure, utilising conceptualdevelopments in the analysis of surface patterns (2003b). Focusing mostly onthe geometrical aspects of surface patterns, Hann identified and classified the symmetrical characteristics of motifs, border patterns, and all-over patterns(2003a). His main findings concern symmetry classification as an analytical tool, andhow it benefits our understanding of surface patterns and their cultural significance.Kraft proposes pattern analysis as an analytical model in her search for subjectiveinfluences, and claims that surface pattern research can contribute to scientifictheory (2004). Using textile analysis as a model, she states that the primary functionof surface patterns is complexity reduction, and focuses on textile productionprocesses and the related environment in order to show that surface patterns *do*have potential epistemological functions – that patterns are able to show *something*.Kraft's model touches upon several subjects, including philosophy, science,and biology, and has the stated intention of positioning the surface pattern as anepistemological object.

The ACSD model is a design model, and dependent on its context. In contrast tothe models of Hann and Kraft, this model focuses on explaining how surfacepatterns that are deployed in a three-dimensional setting contribute in an activemanner to defining spatial determinations. It has been created in order to challengeestablished practice and conventional analytical tools. By analysing the experimentsfor a second time using this model, it is hoped that our knowledge will be expandedthrough an increase in the level of abstraction regarding surface patterns.

II. Materials and Methods

The research presented in this work began as an exploration of a personal interest, and the research issues arose from experience of both the practice and teaching of textile design. This is comparable to what Bye (2010) refers to as "research through practice", wherein a problem or question is derived from practice, and practice is the main method of discovery of other appropriate methods that could be adopted, adapted, or developed. Analysing and questioning these experiences leads to the identification of problems and potential gaps in the research. "Applied research" is another term for the same approach (Muratovski, 2015), as is "constructive design research" (Koskinen*et al.*, 2011), which integrates design and research.

Design Method

The relationships between the concepts outlined above – pattern relations, spatiality, and surface patterns – were experimentally investigated from various viewpoints so as to ensure a strong synergy between theory and practice. Initially, several minor experiments were conducted, which eventually became the design example 'Pattern Relations Exercise 1'. This was followed by analysis, evaluation, reflection, and the formulating of new ideas for subsequent exercises. During evaluation, questions were asked to form a direction for the next experiment, and the outcome of that experiment generated yet more knowledge, guiding the work and moving it forwards. The set-up of the experiments was generally predefined, and the aim had a clear formulation from the beginning. However, a trial-and-error method was applied, and the experiments were carried out with an open mind, accepting the outcome no matter what it was.

For all of the experiments, surface patterns were designed in order to assist in examining pattern relations in spatial contexts. The forms of the pattern units that were used in the examples originate from the work of the Bauhaus regarding elementary geometrical forms (Itten, 1975; Lupton & Miller, 1991), which are the fundamental grammar of the visual. The basic forms of the square, circle, and triangle were chosen because of their status as universal form elements but, as colour was not a focus of this research, black and white were used in the interest of achieving maximum contrast, ensuring that the resulting patterns were clearly visible. Sketching was performed both digitally and manually, and the materials used were paper and textiles.

Scale models were used in Exercises 1 and 2, and were constructed using appropriate sketching materials in order to represent reality. Visually testing ideas in practice has been essential in this work, giving concrete responses to issues relating to both materials and surface patterns, which often interact with and respond to one another. Exercise 3 merged both two- and three-dimensional elements, which is why projection was used as a tool when combining these features.

Experimental Design

The experiments are referred to as Pattern Relations Exercises,and are presented here in chronological order. However, the analysis process has involved a certain amount of jumping back and forth to find similarities and differences. The experiments rest upon and continue from one another, further deepening our perspectives on pattern relations.

In this first design example, pattern relations between a three-dimensional object and a two-dimensional surface were investigated. The initial aim was to explore the transformations of a surface pattern throughout the process of scaling the surface pattern up and down, and to examine the meeting between a two-dimensional surface and a three-dimensional object, and how that creates spatiality (KristensenJohnstone, 2014). The setting was a simple model, consisting of a flat wall, a three-dimensional object – a half-scale mannequin – and a basic black and white surface pattern in six different scales. Using printed versions of the surface pattern on paper and fabric, the six scale steps were applied to both the object and the wall pattern.

2D generates 3D (the power of scale)

Pattern Relations Exercise 2 was comprehensive, and the main experiment of this thesis. The resulting photographs provided a huge quantity of working material and gave the project a number of opportunities for further development. Certain choices were made, then used to derive and identify pattern relationships in spatial contexts with regard to scale. The aim here was to explore scale as a design variable, and to investigate how the scale of a surface pattern can dissolve the plane, surface, and direction of a three-dimensional space and ascertain how this affects visual expression. Basic block-repeated black-and-white surface patterns were designed in three different scales, and each surface pattern was studied in a spatial context using printed versions of the patterns in a scale model. This thesis presents a selection of the results of the entire experiment.

Textile Material. This design experiment focused on textile materials and scale-changing surface patterns in connection with pattern relations. Its purpose was to explore how the movable scales of a surface pattern interact with colourless textile materials, using projection as a design tool. Pattern units were projected onto three types of material, with zooming in and out changing the scale of the surface pattern. The merging of material and movable pattern scale was the main focus of this exercise.

2D meets 3D. 2D meets 3D is a project that explores the pattern relations between a three dimensional object and a two-dimensional surface. This design experiment has its point of departure in three minor experiments that were undertaken earlier in the process, which assisted in framing the direction of the main design example and functioned as guidelines to and foundations for a new perspective on pattern relations. After experimenting with projection, printed fabrics, and digital models, it was decided that the best course of action was to use a physical model and a three-dimensional object (a half-scale mannequin). The first experiments led to the insight that, in order to explore the notion of pattern relations, one must go past established ideas and methods and raise the level of abstraction further. A basic surface pattern was designed in six different scales, from small to large. The pattern unit was a geometric, non-representative, all-over pattern, and was chosen because of its simplicity. To achieve maximum contrast, the surface pattern was black and white, and repeated using the block method.

These design choices were made in order to clearly illustrate changes in the spatial environment, including both similarities and differences. Printed versions of the surface pattern were attached to a plain wall, and the mannequin was draped in digitally printed fabrics. Altering the surface pattern in six scales on both the

wall and the mannequin produced 36 variants. The experiment was conducted in a photography studio, and documented by photographs that were all taken from the same position and using the same lighting conditions.
The result of Exercise 1 was an object in front of a surface or, in other words, two items that interact with each other – an object and a background. The object overlapped the background and functioned as a spatial shaping component. The format included the properties of shape, surface, plane, position, and orientation and was portrait, with the object at the right-hand side. The composition consisted of one vertical plane with two dimensions (those of the object and the wall). There is nothing else in the image that suggests spatiality; there are no perspectives as such.

III. Analysis and Discussion

In the exercise, the relationships between a three-dimensional shape, the scale of a surface pattern, and a surface were investigated. The initial aim was to explore the transformations of a surface pattern throughout the process of scaling the pattern up and down (KristensenJohnstone, 2014). But it was discovered that the characteristics of the grid pattern (the distinct square) change at a certain scale step, at which point the pattern becomes what can be described as a separate shape or an engineered pattern.

It was also concluded that the systematic approach of the experiment could be sharpened even further. The main finding was that, as the surface pattern reached a certain scale, the pattern expression changed from a repeated surface pattern to a form. It is important to note that these findings are only valid for the expression produced by the specific combination of this surface pattern and these settings, and that other design variables such as style, colour, texture, repetitions, and visual expressions, which are other factors that influence an outcome, have not been investigated; altering these variables in the design would produce very different results in terms of pattern expression.

Analysis 1

Exercise 2 resulted in 360 images of six different patterns (printed on paper and attached to a scale model) in three different scales, photographed from five angles in two sets of lighting conditions, with and without a reference object. The initial aim was to explore pattern scale as a design variable, and to see how scale can dissolve the plane, surface, and two-dimensionality of a three-dimensional space. When working with basic forms, form itself is a design variable. The circle – a distinct circular shape without angularity or direction (Wong, 1993) – was interesting to use in this experiment because of the differences in expression it displays when it is scaled up and down. The square – the finest expression of a spatial idea, complete in itself (Munari, 2016) also resulted in intriguing outcomes in the scaling process.

The equilateral triangle has the most stable form, with its distinctive structure, and signifies stability (Ibid.). Using these basic forms provided many possibilities. The analysis of the experiment was based on the visual expression of the image material. Two criteria were used in the evaluation namely Spatiality and spatial appearance

i. Spatiality and Spatial Appearance

Spatial properties were discernible in many of the images and several topics that facilitate spatiality were identified in order to analyse them:

a. The *reference object* (the *Ant* chair) cast a soft shadow on the ground, making its three-dimensionality – as well as that of the entire composition – easier to recognise. Spatiality and spatial appearance are visible in all of the images where the chair is present, regardless of which angle the photograph was taken from (Appendix 18-21).
b. The *corners* indicate a three-dimensional space, composed of a floor and three walls, and serve to define the limits of the space and 'cut off' the surface pattern. Spatiality as enabled by corners is visible in all of the images, regardless of the angle that the photographs were taken from, but is less obvious in some of the Extra-Large series images that were shot from Position 3 (Appendix 22-25).
c. If the viewer squints, the surface patterns become different *values of grey*, independent of which plane they are situated on. Spatial appearance made possible by values of grey appeared primarily in the Small series, mostly in photographs taken from Positions 1, 3, and 4, all with general lighting (Appendix 26-29).
d. *Pattern scale* influences spatial experience. In the Small and Medium series the scale of the surface pattern facilitated spatiality, partly because of the perspective of the planes but also due to the way in which the surface pattern manifests itself when – due to its small scale – it is seen in its totality. The perspective, size, and direction of surface patterns enabled spatiality, as is most obvious in Appendix 30-33.
e. The opposite – *lack of spatial appearance* – occurred in the Extra-Large series. Without the reference object, spatial understanding disappears, as the corners 'cut off' the surface pattern in such a way that there is no clear view of the space (Appendix 34-37). The lighting conditions were utilised in such a way that they influenced spatial perception, regardless of which light source was being used. To some extent the

direction of the surface pattern indicated spatiality, resulting from the various angles from which photographs were taken, as did the angle of the plane that the surface pattern was attached to.

These above-discussed topics were used as main principles during the analysis.

Transformation from surface pattern to form

The changes from surface pattern to form were most evident in the surface patterns in the Extra-Large scale), in which the pattern units were no longer repeated, but rather freestanding compositions. As the wall and base planes delimited the pattern unit, what was left were black and white areas. What was particularly noticeable in the images was that the spatial qualities produced by the patterns became less clear, with no reference object suggesting space. Although the corners delimited the surface pattern, the effect produced was not spatial, but consisted of an abstract, black and white composition. The surface pattern changes were largely evident without the reference object.

Transformation 1 – from surface pattern to form: The surface pattern on the Extra- Large scale dissolved the repetition and transformed the surface pattern into an abstract composition.

Transformation 2 – from surface pattern to stripes and surfaces: The surface pattern on the Small scale changed the pattern to stripes and/or surfaces, and generated a diagonal, checked surface pattern.

Applying scale as a design variable turned out to be key in exploring these areas, as scale has a large impact on visual expression. Using scale as the core of the design experiment gave rise to three questions: In what ways could these results influence the design processes of textile designers? Is it reasonable to assume that they might lead to certain kinds of aesthetics? How could these discoveries be developed into valid design methods?

IV. Conclusion and Future Work

The research described in this licentiate research aimed to explore surface patterns as spatial definers, and what this means in a surface pattern context. It also intended to apply conceptual spatial determinations as alternative design variables in design processes, and explore how they could be used to define and analyse pattern relations. This has resulted in three outcomes: The design experiments: Pattern relations in spatial contexts were explored using scale as a design variable. Three design exercises addressed the issue from different perspectives and demonstrated the expressional possibilities that a surface pattern can create in a defined space, and how this is connected to pattern relations. The theoretical model: The ACSD model used conceptual spatial determinations to analyse the design experiments, raising the level of abstraction in relation to surface patterns. The outcome of the second analysis, which was carried out using the model, showed that alternative analysis methods have great potential in relation to surface design, in that they allow to view surface patterns in terms of conceptual spatial determinations, rather than as traditional, functional patterns.

The workshops: Abstract design variables with regard to conceptual spatial determinations were introduced into the design process to provide an alternative working method in surface pattern design. The results of the workshops demonstrated the potential of using conceptual spatial determinations as design variables, as the design solutions were clearly influenced by the introduction of these design variables.

These four outcomes may contribute to the field of textile design, and surface pattern design more specifically, the process of which could become increasingly abstracted, leading to a change to and supplement of the design process by:

i. Defining pattern relations in a textile design context.
ii. Analysing patterns and positing them as spatial definers.
iii. Developing surface pattern design processes by introducing conceptual spatial determinations as design variables.
iv. Highlighting an area that is rarely in focus within design research – surface pattern design – and exploring it further in relation to the broader concept of patterns.

Several possible avenues of future work have arisen in relation to this research. Due to the limitations of this work, certain aspects of surface pattern design were not investigated, and these further approaches could enhance and expand upon the contribution to knowledge as it stands at present. With regard to the design experiments, there is an opportunity to examine pattern relationships, surface pattern, and scale in spatial contexts in relation to human interaction by producing counter-examples to Exercises 1-3. The intention with such an exploration would be to see these issues from new perspectives, rethink conventions, push the limits of the field, open up for further discussion, and problematise the matter. Using the same digital tool as was used in Exercise 3, this process would involve examining a surface design that changed scale based on the distance between the viewer and the projected surface pattern: The closer the viewer, the larger the scale of the surface pattern would appear to be. In that experiment, things would be turned upside-down in order to engender a 're-understanding' and reconsideration of established practices.

As discussed in the previously, the workshops have great potential, and could serve as a foundation from which to develop surface pattern design processes. Using workshops as a means of gaining valuable insights and knowledge is an idea that is close to the author's heart, due to the fact that working with design students is great fun, unpredictable, and most of all, rewarding. Another possibility would be to conduct experiments using more complex surface patterns with different characteristics in order to be able to study scale, viewing, distance, and viewing angle. The surface patterns that were used in this project were relatively simple; complexity could be increased through greater pattern intricacy. This approach would benefit from the research including varying types of form. Surface patterns and form are closely related areas, and studying the two together would be an interesting next step.

Monochromatic colour combinations were used in the design experiments, but other colour combinations could be explored. Several ideas for using colour with surface patterns have occurred over the course of the work, but have proved to be beyond the scope of this research. Investigating colour in more detail has great potential for future studies, and could involve repeating the experiments that have been carried out with other colour combinations. The current theoretical frameworks relating to colour could benefit from scientific exploration in the context of surface patterns. The possibility of investigating phenomena in which colours appear to advance and recede, or visual effects occur when certain colours are used together, is discussed by Itten (Itten&Birren, 1970) and Albers (2013), and could be a fruitful avenue of future research. This area would benefit greatly from experimentation in a surface pattern context following some of the methods used in this thesis.

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